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* * *

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UL 17

STANDARDS for SAFETY

VENT OR CHIMNEY CONNECTOR DAMPERS FOR OIL-FIRED APPLIANCES

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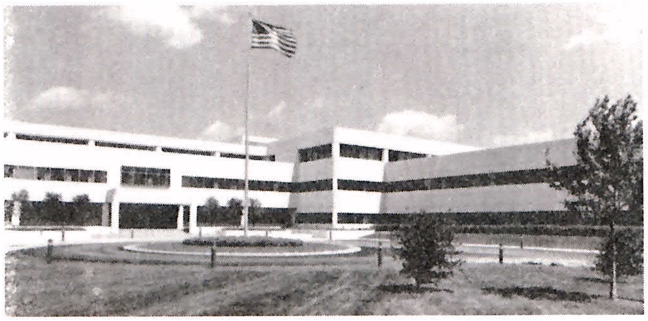

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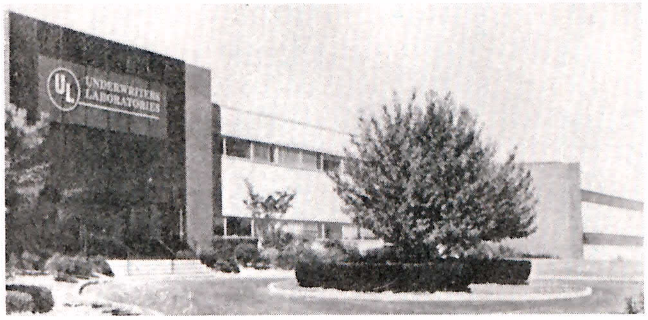

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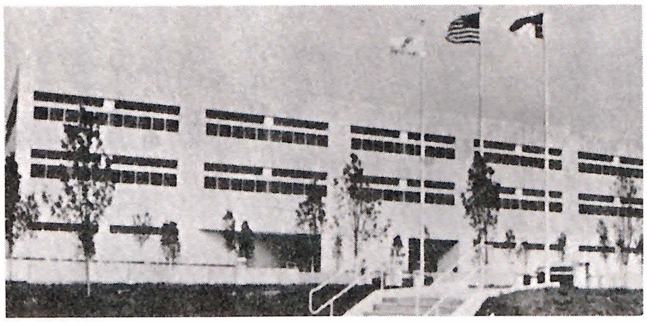

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NOVEMBER 28, 1988

STANDARD FOR

VENT OR CHIMNEY CONNECTOR DAMPERS FOR OIL-FIRED APPLIANCES

UL 17, SECOND EDITION

Accompanying this transmittal notice is a copy of the second edition of UL 17.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

As indicated on the title page, this UL Standard for Safety is an American National Standard.

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UL 17

STANDARD FOR

VENT OR CHIMNEY CONNECTOR DAMPERS FOR OIL-FIRED APPLIANCES

First Edition — July, 1982

SECOND EDITION

November 28, 1988

Approval as an American National Standard covers the numbered paragraphs on pages dated November 28, 1988. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the approved text. Revisions of this standard will be made by issuing revised or additional pages bearing their dates of issue.

Approved as ANSI/UL 17-1983, August 5, 1983
Approved as ANSI/UL 17-1988, April 18, 1988

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

GENERAL

1. Scope

1.1 These requirements cover electrically operated damper assemblies, that are intended for installation in the vent or chimney connector of automatically operated oil-fired appliances employing an atomizing type oil burner. The damper assembly is intended to restrict or block the connector opening when the burner is not firing.

1.2 These requirements cover automatic vent or chimney connector dampers for oil-fired appliances having a flue gas temperature not in excess of 538°C (1000°F), unless marked for a lower temperature. See paragraphs 5.1 and 20.24 and item D of paragraph 33.1.

1.3 The vent or chimney connector dampers covered under these requirements are not for use on oil-fired appliances that employ vaporizing type oil burners.

1.4 Automatic vent or chimney connector dampers are intended for installation in accordance with the following standards of the National Fire Protection Association:

A. Oil-Burning Equipment, NFPA 31.

B. Chimneys, Fireplaces, and Vents, NFPA 211.

C. National Electrical Code, NFPA 70.

2. Installation Instructions

2.1 A copy of the installation instructions intended to accompany each damper assembly is to be used as a guide in the examination and test of the damper assembly. For this purpose, a final printed copy is not required.

2.2 The installation instructions shall include instructions and information for installation, maintenance, and operation of the damper assembly. At least the following information shall be included:

A. A statement that the damper assembly is to be installed by a qualified agency.

B. Specification that the damper assembly is for installation only on an automatically operated oil-fired appliance employing an atomizing type burner.

C. Unless the damper assembly has been found acceptable for use with an appliance that includes a constant burning pilot, instructions shall be included that the damper assembly shall not be used on an appliance that employs a constant burning pilot.

D. A warning statement that the damper assembly shall be installed in the vent or chimney connector that serves to vent only the single oil-fired appliance to which the damper assembly is electrically connected.

E. Installation clearances to adjacent combustibles. Such clearance dimensions shall (1) be in integral inches and (2) clearly indicate the reference surface(s) of the damper assembly from which the clearances are to be measured.

F. If the damper assembly is intended for use on an appliance having a maximum flue-gas temperature less than 538°C (1000°F), the maximum flue gas temperature shall be specified and instructions shall be included concerning the method to be used to determine the flue gas temperature.

G. The location of the damper assembly in the vent or chimney connector with respect to the related appliance and other devices in the venting system, such as an automatic draft regulator.

H. Instructions and illustrations for electrical connections including temperature rating of conductors if higher than commonly used 60°C rated wiring materials are to be employed. If the installation involves rewiring of existing connections in the control circuit of the appliance, precise instructions for accomplishing this and typical wiring diagram(s) shall be included.

I. Instructions that the damper assembly is not to be used with a direct vent system (sealed combustion system) appliance.

J. Any limitations on the mounting position of the damper assembly with respect to the vent or chimney connector.

K. Maximum ambient temperature if applicable.

L. Instructions for checkout procedure after the installation has been completed to determine that the damper assembly is installed as intended and that both the damper assembly and the oil-fired appliance are operating as intended.

3. Glossary

3.1 For the purpose of this standard, the following definitions apply.

3.2 CHIMNEY CONNECTOR — The conduit that connects a heating appliance with a vertical flue.

3.3 COMBUSTIBLE MATERIAL, COMBUSTION PRODUCTS, NONCOMBUSTIBLE MATERIALS — These terms, as used in this standard, are defined in the Standard Glossary of Terms Relating to Chimneys, Vents, and Heat-Producing Appliances, ANSI/NFPA 97M-1988.

3.4 DIRECT VENT SYSTEM APPLIANCE — (Also called "sealed combustion system appliance.") A self-contained appliance that by its inherent design, is constructed so that all air supplied for combustion, the combustion system of the appliance, and all products of combustion are completely isolated from the atmosphere of the space in which it is installed.

3.5 DRAFT REGULATOR — A device that functions to maintain a desired draft in an oil-fired appliance by automatically reducing the chimney draft to the desired value.

3.6 ELECTRICAL CIRCUITS:

A. High-Voltage Circuit — A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage or an isolated limited secondary circuit.

B. Low-Voltage Circuit — A circuit involving a potential of not more than 30 volts ac (42.4 volts peak or dc) and supplied by a primary battery or by a standard Class 2 transformer, or by a combination of transformer and fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer. (A circuit derived from a source of supply classified as a high-voltage circuit, using resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage nor an isolated limited secondary circuit.)

C. Safety Control Circuit — A circuit involving one or more safety controls that open the circuit in the event of grounding, opening, or shorting of any part of the circuit.

D. Isolated Limited Secondary Circuit — A circuit of limited energy derived from an isolated secondary winding of a transformer having a maximum capacity of 100 volt-amperes and open-circuit secondary voltage not exceeding 1000 volts.

3.7 SEALED COMBUSTION SYSTEM APPLIANCE — See "direct vent system appliance," paragraph 3.4.

3.8 VENT CONNECTOR — The conduit that connects a heating appliance to a vertical vent.

4. General

References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

Components and Units of Measurement

4.2 Except as indicated in paragraph 4.3, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

4.3 A component need not comply with a specific requirement that:

A. Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or

B. Is superseded by a requirement in this standard.

4.4 A component shall be used in accordance with its recognized rating and established for the intended conditions of use.

4.5 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

4.6 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

CONSTRUCTION

5. Assembly

General

5.1 A vent or chimney connector damper shall be constructed and assembled so that it will (1) withstand a flue gas temperature of at least 538°C (1000°F) and (2) have the strength and rigidity necessary to resist the abuses to which it may be subjected, without total or partial collapse or without reduction of spacings, loosening or displacement of parts, or other serious defects, when it is tested in accordance with the requirements of this standard.

Exception: A vent or chimney connector damper may be intended for a flue gas temperature less than 538°C but not less than 399°C (750°F) provided the assembly is marked in accordance with item D of paragraph 33.1.

5.2 A joint in metal surfaces of a flue gas passageway shall be tight, as attained by being welded, lock-seamed, riveted, or bolted.

5.3 If a vent or chimney connector damper consists of two or more subassemblies that are to be joined in the application to form one assembly, each subassembly shall be constructed for ready attachment of one to the other without requiring alteration, drilling, welding or cutting or a similar task by the installer. The securement of subassemblies to each other shall be by use of conventional means such as screws or bolts and such securement means shall be provided as part of the subassemblies.

5.4 With respect to paragraph 5.3, the subassemblies that must bear a definite relationship to each other in order to operate as intended shall be arranged and constructed so as to permit them to be assembled only in the correct relationship with each other.

5.5 All operating parts of a vent or chimney connector assembly shall be secured against displacement and shall be constructed so as to maintain a fixed relationship between the parts under intended conditions of operation and handling.

5.6 The construction of the vent or chimney connector damper shall be such that it permits, after burner shutdown, the escape of the products of combustion and hot gases that may be present in the combustion chamber of the appliance. The means provided for this purpose shall comply with the requirements in paragraph 5.7.

5.7 To comply with the requirement in paragraph 5.6, the vent or chimney connector damper shall include a time-delay feature that delays the closing of the damper blade so that it does not attain a fully closed position until a minimum of 3 minutes after the burner shutdown.

Exception No. 1: Less than 3 minutes time-delay may be provided if the vent or chimney connector damper assembly is tested as described in paragraphs 21.1 — 21.3.

Exception No. 2: No time-delay is required if the damper blade provides, in the fully closed position, some free venting area and the vent or chimney connector damper assembly is tested as described in paragraphs 21.1 — 21.3.

5.8 A vent or chimney connector damper assembly shall interlock electrically with the oil burner primary safety control so that the burner can be fired only if the damper blade is in a fully open position.

5.9 A vent or chimney connector damper assembly intended for use with an oil-fired appliance that includes a constant burning gas pilot shall provide an internal free venting area of the vent gas passageway of not less than 5 percent of the total outlet free venting area.

5.10 The inlet and outlet connections of a vent or chimney connector damper assembly shall be of the same nominal size and shall accommodate commercially available flue pipe sizes of integral inch diameter such as 4, 5, 6, 7, 8, 9, 10, and 12.

5.11 The inlet and outlet connections shall each provide at least a 1-1/4 inch (31.7 mm) insertion depth (lip) for the attachment of the vent or chimney connector pipe.

5.12 The vent or chimney connector vent damper assembly shall be constructed so that, with the damper blade in its intended fully open position, the internal free venting area of the vent or chimney connector on which the assembly is intended to be installed is not reduced by more than 5 percent.

5.13 The vent or chimney connector vent damper assembly shall include an indicator that is visible during operation of the vent damper to signify the position of the damper blade.

5.14 A pilot or signal light that is used to indicate the damper blade position shall be arranged so that impaired operation of the light (such as a burned out bulb) would not signify an open damper blade position.

Electrical Circuits

5.15 The primary input to a safety control circuit shall be a 2-wire, one-side-grounded system, having a voltage rating of a nominal 120 volts. A switch or protective device in the circuit shall be electrically connected to the ungrounded supply conductor.

6. Materials

6.1 The parts of a vent or chimney connector damper assembly that serve as a passageway for the flue gases or otherwise are in direct contact with the flue gases shall be made of stainless steel, cast iron, aluminum-coated or hot-rolled steel or other metals having equivalent durability and resistance to corrosion, fire, and heat. The maximum temperature ratings of materials are specified in Table 20.2.

6.2 With reference to paragraph 6.1, the thickness including coatings, of stainless steel shall not be less than 0.012 inch (0.3 mm), and neither aluminum-coated nor hot-rolled steel shall be less than 0.032 inch (0.81 mm).

6.3 Galvanized steel may be used in the same thickness and at the same temperature as hot-rolled steel, provided galvanizing is not required as a protective coating or for the reflectivity of the surface to reduce the risk of fire.

6.4 A part made of drawn brass or machined from brass rod shall withstand, without cracking, a mercurous-nitrate test for copper and copper alloys. See paragraphs 28.1 — 28.4.

7. Springs

7.1 A spring shall be of a material that is protected against corrosion.

7.2 If impaired operation of a spring may cause the damper blade to remain in the closed or partially closed position, the construction and application of the spring employed shall be such that corrosion, fatigue, overstress, wear, or abrasion is not likely to impair operation of the spring nor remove it from its intended position.

8. Enclosure

General

8.1 Uninsulated live high-voltage parts shall be enclosed or guarded to reduce the likelihood of unintentional contact by persons during intended use of the equipment. This requirement applies also to such parts located in a compartment into which access is required for intended care of the vent or chimney connector damper, such as resetting controls, lubricating, cleaning, or the like.

8.2 A polymeric material shall comply with the requirements applicable to fixed equipment in the Standard for Polymeric Materials — Use in Electrical Equipment Evaluations, UL 746C.

8.3 Sheet metal complying with Tables 8.1 or 8.2, whichever applies, is acceptable for the individual enclosure of electrical components.

8.4 If the design and location of components and the strength and rigidity of the outer cabinet warrant, an individual enclosure thinner than that specified in Table 8.1 or 8.2, whichever applies, may be employed.

8.5 A steel enclosure shall be protected against corrosion by painting, plating, or other equivalent means.

8.6 The enclosure shall prevent the emission through its openings of molten metal, burning insulation, flaming particles, or the like, that may occur inside.

8.7 If insulating material other than electrical insulation is provided within the enclosure, consideration shall be given to the burning characteristics and combustibility of the material and the proximity of an ignition source.

8.8 All intended mounting positions of the vent or chimney connector damper shall be considered when determining if it complies with the requirements in paragraphs 8.6 and 8.7.

Doors and Covers

8.9 A cover or access panel of an enclosure for uninsulated live parts shall be provided with means for securing it in place.

8.10 A hinged or pivoted panel or cover shall be positioned or arranged in such a manner that, due to gravity or vibration, it is not subject to falling or swinging that may cause injury to persons by exposing moving parts or uninsulated live parts.

8.11 The assembly shall be arranged so that an overload protective device such as a fuse, the intended functioning of which requires renewal, can be replaced, and a manual-reset device can be reset without removing parts other than a service cover or panel and a cover or door. See paragraph 8.14.

8.12 A required protective device shall be wholly inaccessible from outside the vent or chimney connector damper without opening a door or cover.

Exception: The operating handle of a circuit breaker, the operating button of a manually operable motor protector, and similar parts may project outside the vent or chimney connector damper enclosure.

8.13 A fuseholder shall be constructed, installed, or protected so that adjacent uninsulated high-voltage live parts within 4 inches (102 mm), other than the screw shell of a plug fuseholder, cartridge fuse clip, or wiring terminal to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. An insulating barrier or vulcanized fiber or similar material employed for this purpose shall not be less than 0.028 inch (0.71 mm) in thickness.

8.14 Except as indicated in paragraph 8.15, a door or cover of an enclosure that provides access to any overload-protective device that requires resetting or renewal shall be hinged or otherwise attached in an equivalent manner.

8.15 A hinged cover is not required for a device in which the only fuses enclosed are (1) control-circuit fuses of 2 amperes or less, provided the fuses and control-circuit loads, other than a fixed control-circuit load, such as a pilot lamp, are within the same enclosure, or (2) extractor-type fuses, each with its own enclosure, or (3) fuses in low-voltage circuits.

8.16 A hinged cover, where required, shall not depend solely upon screws or other similar means requiring the use of tools to hold it closed, but shall be provided with a catch or spring latch.

8.17 A spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the door in place and would require some effort on the user's part to open is considered to be an acceptable means for holding the door as required by paragraph 8.16.

8.18 A door or cover giving direct access to fuses in other than low-voltage circuits shall shut closely against a 1/4-inch (6.4-mm) rabbet or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the wall of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A construction which affords equivalent protection, such as a fuse enclosure within an outer enclosure or a combination of flange and rabbet is acceptable.

8.19 A strip used to provide a rabbet, or an angle strip fastened to the edge of a door, shall be secured at no fewer than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

TABLE 8.1
MINIMUM THICKNESS OF SHEET METAL FOR ELECTRICAL ENCLOSURES
CARBON STEEL OR STAINLESS STEEL

(TE-105-2)

Without Supporting Frame[a]				With Supporting Frame or Equivalent Reinforcing[a]				Minimum Thickness in Inches (mm)			
Maximum Width[b]		Maximum Length[c]		Maximum Width[b]		Maximum Length		Uncoated (MSG)		Metal Coated (GSG)	
Inches	(cm)	Inches	(cm)	Inches	(cm)	Inches	(cm)				
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020	(0.51)	0.023	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)	(24)		(24)	
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026	(0.66)	0.029	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)	(22)		(22)	
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)	(20)		(20)	
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)	(18)		(18)	
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited		0.053	(1.35)	0.056	(1.42)
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)	(16)		(16)	
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited		0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)	(15)		(15)	

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes: (1) a single sheet with single formed flanges (formed edges), (2) a single sheet that is corrugated or ribbed, and (3) an enclosure surface loosely attached to a frame, for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels that are not supported along one side, such as side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

TABLE 8.2
MINIMUM THICKNESS OF SHEET METAL FOR ELECTRICAL ENCLOSURES ALUMINUM, COPPER, OR BRASS

(TE-115-2)

Without Supporting Frame[a]				With Supporting Frame or Equivalent Reinforcing[a]				
Maximum Width[b] Inches	(cm)	Maximum Length[c] Inches	(cm)	Maximum Width[b] Inches	(cm)	Maximum Length Inches	(cm)	Minimum Thickness, Inches (mm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023
3.5	(8.9)	4.0	(10.2)	8.5	(21.6)	9.5	(24.1)	(0.58)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0.029
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.3)	(0.74)
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)	(0.91)
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited		0.045
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)	(1.14)
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)	(1.47)
18.0	(45.7)	Not limited		42.0	(106.7)	Not limited		0.075
20.0	(50.8)	25.0	(63.5)	45.0	(114.3)	55.0	(139.7)	(1.91)

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes: (1) a single sheet with single formed flanges (formed edges), (2) a single sheet that is corrugated or ribbed, and (3) an enclosure surface loosely attached to a frame, such as with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure.
Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels that are not supported along one side, such as side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

Openings

8.20 An opening in an enclosure to provide clearance around a dial, knob, lever, or handle shall not allow the entrance of a rod having a diameter of 9/64 inch (3.6 mm) at any setting or position of the dial, knob, or the like.

8.21 Ventilating openings in an enclosure shall be judged on the basis of the necessity for their existence, their size and location, and the aggregate area of all the openings involved, in accordance with the following:

A. A ventilating opening shall be necessary to prevent the attainment of excessive temperatures on parts of the control, as demonstrated by a temperature test with such an opening blocked.

B. Openings other than those necessary for mounting the assembly shall not be located in the bottom or in the mounting surface of the enclosure.

C. The nearest portion of a ventilating opening shall be above the bottom of the enclosure and away from the wall mounting surface by a distance equal to one-quarter of the enclosure height and depth, respectively, or 1 inch (25.4 mm), whichever is less.

D. If an enclosure houses fuses or any portion of a circuit breaker other than the operating handle, a ventilating opening shall not be provided unless the construction affords containment of electrical fault disturbances equivalent to that provided by the requirements in paragraphs 8.18 and 8.19.

E. The compartment or that part of an enclosure that contains field-wiring splices in the high-voltage circuit shall not be provided with ventilating openings.

F. There shall be no emission of flame or molten material from an opening, or other evidence of fire, during tests such as transformer burnout and burnout of relays with blocked armature.

G. An opening shall not permit entrance of a 3/4-inch (19.1-mm) diameter rod.

H. An opening shall be arranged so that a probe, as illustrated in Figure 8.1, cannot be made to touch any uninsulated live part when inserted through the opening.

I. An opening shall be so arranged that a probe, as illustrated in Figure 8.2 cannot be made to touch film-coated wire when inserted through the opening.

FIGURE 8.1
PROBE FOR UNINSULATED LIVE PARTS

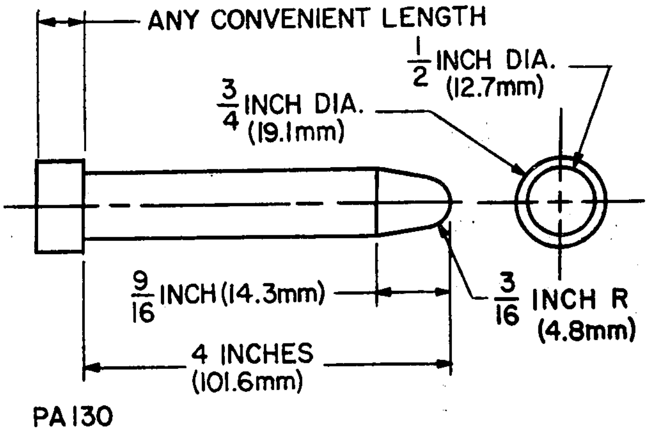
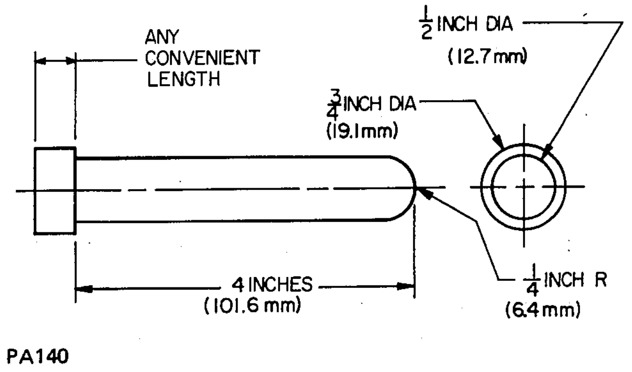

ANY CONVENIENT LENGTH
$\frac{1}{2}$ INCH DIA. (12.7mm)
$\frac{3}{4}$ INCH DIA. (19.1mm)
$\frac{9}{16}$ INCH (14.3mm)
$\frac{3}{16}$ INCH R (4.8mm)
4 INCHES (101.6mm)
PA130

FIGURE 8.2
PROBE FOR FILM-COATED WIRE


ANY CONVENIENT LENGTH
$\frac{1}{2}$ INCH DIA (12.7mm)
$\frac{3}{4}$ INCH DIA (19.1mm)
4 INCHES (101.6 mm)
$\frac{1}{4}$ INCH R (6.4mm)
PA140

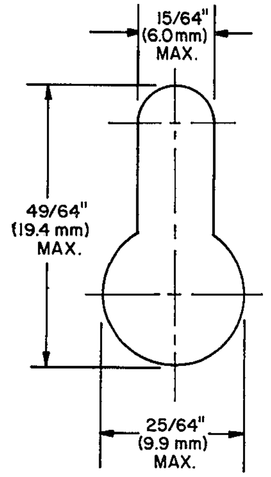
8.22 Except as permitted by paragraphs 8.20 and 8.21, the enclosure shall have no openings other than:

A. Not more than four unused holes intended for mounting various components inside the enclosure. The largest dimension of each such opening shall not be greater than 5/32 inch (4.0 mm) (No. 8 screw size diameter).

B. Not more than four holes 1/8 inch (3.2 mm) or less in diameter for the escape of air or drainage of paint during the painting process if they are located as close to the corners of the enclosure as possible.

C. Not more than four holes for mounting of the assembly, if required. These holes may be of configuration and dimensions shown in Figure 8.3.

FIGURE 8.3
KEYHOLE SLOT



EC 600

a SI values for the dimensions in this figure are:

Inch	(mm)
15/64	6.0
49/64	19.4
25/64	9.9

9. Supply Connections

General

9.1 In the following paragraphs, and particularly where wiring terminals or leads are mentioned, wiring connections are considered to be those that are to be made when the assembly is installed.

9.2 An automatic vent or chimney connector damper and its associated remote control assembly, if provided, shall have provision for connection of one of the wiring systems that, in accordance with the National Electrical Code, NFPA 70-1981, is acceptable for the control.

9.3 An assembly that is for use only with fittings on one type of wiring system shall be supplied with such a fitting. See item M of paragraph 33.1.

9.4 A vent or chimney connector damper and its associated remote control assembly, if used, shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70-1981, corresponding to the rating of the unit.

9.5 A terminal box or wiring compartment shall be located so that wire connections therein will be accessible for inspection, without disturbing either high-voltage or safety-circuit wiring, after the damper assembly is installed in the intended manner.

Exception: For an outlet box mounted unit, wire connections may be accessible upon removal of the unit from the outlet box.

Lead Wires

9.6 A lead shall be Type T wire or wire having insulation equivalent in electrical and mechanical properties to Type T wire. Such a lead shall not be smaller than No. 18 AWG (0.82 mm^2) and shall have a free length of at least 6 inches (152 mm).

9.7 A lead for field connection shall be provided with strain relief so that mechanical stress is not transmitted to terminals, splices or interior wiring. Each lead shall be capable of withstanding for 1 minute a pull of 10 pounds (4.5 N).

9.8 The surface of:

A. An insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other conductor visible to the installer shall be so identified.

B. A lead intended for connection of a grounded supply conductor shall be finished to show a white or natural gray color and shall be distinguishable from the other leads.

Terminals

9.9 A wiring terminal shall be provided with a pressure wire connector fastened in place by a bolt or screw.

Exception: A wire-binding screw may be employed at a wiring terminal intended to accommodate a No. 10 AWG (5.3 mm^2) or smaller conductor if upturned lugs, corners, or the equivalent are provided to hold the wire in place.

9.10 A wire-binding screw shall be not smaller than No. 8 (4.2 mm diameter).

Exception: A No. 6 (3.5 mm diameter) screw may be used for the connection of a conductor not heavier than No. 14 AWG (2.1 mm^2).

9.11 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) in thickness for a No. 14 AWG (2.1 mm^2) wire and not less than 0.050 inch (1.27 mm) in thickness for a wire larger than No. 14 AWG; and in either case, there shall not be less than two full threads in the metal.

9.12 A wire-binding screw shall thread into metal.

9.13 A terminal shall be constructed so that the conductor will make metal-to-metal contact with the terminal plate as well as with any wire binding screw when the conductor is secured to the terminal.

9.14 A terminal intended for connection of a grounded supply conductor shall be of or plated with metal that is substantially white in color and shall be readily distinguishable from other terminals, or identification of that terminal shall be shown in some other manner, such as on an attached wiring diagram.

9.15 A terminal intended for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size acceptable for the particular application, in accordance with the National Electrical Code, ANSI/NFPA 70-1981.

9.16 A wire-binding screw intended for the connection of an equipment grounding conductor shall have a slotted, or hexagonal green-colored head. A pressure wire connector intended for connection of such a conductor shall be identified by being marked “G,” “GR,” “Ground,” “Grounding,” or by a marking on a wiring diagram provided on the assembly. The wire-binding screw or pressure wire connector shall be located so that it is unlikely to be removed during intended servicing of the assembly.

9.17 If the assembly includes a lampholder of the Edison screw shell type, the identified grounded terminal or lead shall be electrically connected to the screw shell of the lampholder.

Wiring Space

9.18 Space shall be provided within the enclosure of an assembly to allow room for the distribution and storage of wires and cables required for the wiring of the assembly.

10. Current-Carrying Parts

10.1 A current-carrying part shall be silver, copper, copper alloys, or other metal acceptable for such use.

10.2 Uninsulated live parts, including terminals and contact assemblies, shall be secured to their supporting surfaces by methods other than friction between surfaces so that they will be prevented from turning or shifting in position.

10.3 A lock washer is generally acceptable to prevent turning of a terminal or connection stud.

11. Mounting of Electrical Components

11.1 A switch, fuseholder, lampholder, or similar electrical component shall be mounted to prevent it from turning.

Exception No. 1: A switch need not be prevented from turning if all of the following conditions are met:

A. The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during intended operation of the switch.

B. The means for mounting the switch makes it unlikely that operation of the switch will loosen it.

C. The spacings are not reduced below the required values if the switch rotates.

D. The intended operation of the switch is by mechanical means rather than by direct contact by a person.

Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the required values.

11.2 The means for preventing turning is to consist of more than friction between surfaces: a toothed lock washer that provides both spring takeup and an interference lock is acceptable as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

11.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the acceptable values.

12. Internal Wiring

12.1 The internal wiring of an assembly shall consist of wires of a type or types that are acceptable for the temperature and voltage to which the wiring is to be subjected.

12.2 Except as provided in paragraphs 12.4 and 12.5, the internal wiring of a damper assembly shall consist of insulated conductors having an acceptable voltage rating and current-carrying capacity. Insulated conductors for high-voltage circuits shall be Type T wire or wire having insulation equivalent in mechanical and electrical properties to that of Type T wire. Insulated conductors for low-voltage safety-control and isolated limited secondary circuits shall be Type RF-1 or TF or wiring having insulation equivalent in electrical and mechanical properties to that of Type RF-1 or TF wire. See paragraph 13.1.

12.3 These requirements are not intended to exclude the use of printed wiring material.

12.4 If the use of a short length of an insulated conductor is not feasible (for example, a short coil, lead, or the like), noncarbonized leads or electrical insulating tubing may be employed. Tubing shall not be subjected to sharp bends, tension, compression, or repeated flexing, and shall not contact sharp edges, projections, or corners. The wall thickness at any point for the smallest sizes of polyvinyl chloride tubing shall not be less than 0.017 inch (0.43 mm). For insulating tubing of other types, the thickness shall not be less than that providing mechanical strength, dielectric properties, heat- and moisture-resistant characteristics, and the like, at least equal to those of 0.017 inch thick polyvinyl chloride tubing.

12.5 A bare conductor may be employed within an enclosed control for a short wire length if it is impractical to insulate such a conductor.

12.6 A bare conductor or a conductor utilizing tubing or noncarbonizable beads for insulation shall not be employed outside of an enclosed unit. A bare conductor shall be supported so that the required spacings will be maintained.

12.7 A wireway shall be smooth and free from sharp edges, burrs, fins, moving parts, and the like, that may cause abrasion of the insulation on conductors. A mounting screw shall not project more than 3/16 inch (4.8 mm) into a wireway and shall have a flat or blunt end.

12.8 A hole in a metal wall, through which insulated wires not enclosed in conduit pass, shall be provided with a smoothly rounded bushing, or shall have a smooth, rounded surface upon which the wires may bear. A bushing shall be phenolic, porcelain, or hard fiber.

12.9 A hole in porcelain, phenolic composition, or other nonconducting material and having a smoothly rounded surface is considered to be the equivalent of a bushing.

12.10 Ceramic materials and some molded compositions are generally acceptable for an insulating bushing; but a bushing of wood or hot-molded shellac and tar compositions is not acceptable.

12.11 A fiber bushing shall not be less than 1/16 inch (1.6 mm) thick, with a minus tolerance of 1/64 inch (0.4 mm) for manufacturing variations, and shall not be employed where it will be subjected to a temperature higher than 90°C (194°F) under intended operating conditions.

12.12 To provide an acceptable unbushed opening in sheet metal usually requires rolling or extrusion of the metal around the opening or the insertion of an acceptable grommet.

12.13 Each splice and connection shall be mechanically secure and shall provide reliable electrical contact without strain on connections and terminals. Except as noted in paragraph 12.14, soldered connections shall be mechanically secure before being soldered.

12.14 A connection made to a printed wiring board need not be made mechanically secure provided the soldering is done by a machine in a process where the soldering time and solder temperature are automatically controlled.

12.15 A splice shall be provided with insulation equivalent to that required for the wires involved if permanence of spacing between the splice and uninsulated live parts of opposite polarity or grounded dead metal parts may not be maintained.

13. Separation of Circuits

13.1 Unless provided with insulation for the highest voltage involved, insulated conductors of different circuits (internal wiring) shall be separated by barriers or shall be segregated from uninsulated live parts connected to different circuits or opposite-polarity parts of the same circuit.

13.2 Segregation of insulated conductors may be accomplished by clamping, routing, or an equivalent means that provides permanent separation from insulated or uninsulated live parts of a different circuit.

13.3 A metal barrier shall have a thickness at least as great as that specified in Table 8.1 or 8.2, as applicable, based on the size of the barrier. A barrier of insulating material shall not be less than 0.018 inch (0.71 mm) thick and shall be of greater thickness if its deformation may be readily accomplished so as to defeat its purpose. Any clearance at the edges of a barrier shall not be more than 1/16 inch (1.6 mm) wide.

13.4 Openings in a barrier for the passage of conductors shall not be larger than 1/4 inch (6.4 mm) in diameter and shall not exceed in number, on the basis of one opening per conductor, the number of wires which will need to pass through the barrier. The closure for any other opening shall present a smooth surface wherever an insulated wire may be in contact with it; and the area of any such opening, with the closure removed, shall not be larger than required for the passage of the necessary wires.

14. Bonding for Grounding

14.1 Each separately installed subassembly of a vent or chimney connector damper that includes electrical components and circuits, except one that includes only low-voltage circuits, shall be provided with an equipment grounding terminal or lead.

14.2 All exposed or accessible noncurrent-carrying metal parts that are likely to become energized by a high-voltage potential and that may be contacted by the use or by service personnel during service operations that are likely to be performed when the equipment is energized, shall be electrically connected to the point of connection of an equipment ground.

14.3 Except as indicated in paragraph 14.4, an uninsulated metal part of a cabinet, an electrical enclosure, motor frame and mounting bracket, controller mounting bracket, capacitor and other electrical component, or the like, are to be bonded for grounding if they may be contacted by the user or serviceman.

14.4 The following metal parts need not be grounded:

A. An adhesive-attached metal-foil marking, screw, handle, or the like, that is located on the outside of an enclosure or cabinet and isolated from electrical components or wiring by grounded metal parts.

B. An isolated metal part, such as a magnet frame and armature, small assembly screw, or the like, that is separated from wiring and uninsulated live parts.

C. A panel or cover that does not enclose uninsulated live parts if insulated parts and wiring are separated from the panel or cover.

D. A panel or cover that is insulated from electrical components and wiring by an attached insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 1/32 inch (0.8 mm) thick.

14.5 A component, such as a switch, that is likely to become separated from its grounding means for purposes of testing or adjustment while the equipment is energized is to be provided with a grounding conductor not requiring removal for such service.

14.6 A splice shall not be employed in a wire conductor used for bonding.

14.7 A metal-to-metal hinge bearing member may be considered as a means for bonding a door for grounding.

14.8 A separate bonding conductor shall be of material rated for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by enameling, galvanizing, plating, or equivalent means. A separate bonding conductor or strap shall (1) be protected from mechanical damage, such as by being located within the confines of the outer enclosure or frame, and (2) not be secured by a removable fastener used for any purpose other than bonding for grounding, unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

14.9 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, or by welding, soldering, or brazing with materials having a softening or melting point greater than 454°C (850°F). The bonding connection shall penetrate nonconductive coatings such as paint or vitreous enamel.

14.10 A connection that depends upon the clamping action exerted by rubber or similar materials is acceptable if it complies with the requirements in paragraph 14.12 under any degree of compression permitted by a variable clamping device, and if the results are still acceptable after exposure to the effects of oil, grease, moisture, and thermal degradation that are likely to occur in service. The effect of assembling and disassembling for maintenance purposes such as a clamping device is to be considered with respect to the likelihood of the clamping device being reassembled in its intended position.

14.11 If bonding depends on screw threads, two or more screws or two full threads of a single screw are to engage the metal.

14.12 If the acceptability of a bonding connection cannot be determined by examination, or if a bonding conductor is smaller than required by paragraphs 14.13 — 14.16, it shall be considered acceptable if the connecting means does not open when carrying for 2 minutes twice the current equal to the rating of the branch circuit overload device required to protect the equipment.

14.13 The size of a conductor or strap employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch circuit overload device to which the equipment will be connected. Except as indicated in paragraph 14.12, the size of the conductor or strap shall be in accordance with Table 14.1.

TABLE 14.1
BONDING WIRE CONDUCTOR SIZE

(B-101-2)

Rating of Overcurrent Device, Amperes	Size of Bonding Conductor[a]			
	Copper Wire		Aluminum Wire	
	AWG	(mm^2)	AWG	(mm^2)
15	14	2.1	12	3.3
20	12	3.3	10	5.3
30	10	5.3	8	8.4

[a] Or equivalent cross-sectional area.

14.14 A bonding conductor to a component or electrical enclosure is not required to be larger than the size of the conductors supplying power to the component or components within the enclosure.

15. Motors and Motor Overload Protection

15.1 A motor shall be provided with overload protection that consists of one of the following:

A. Thermal protection complying with the applicable requirements in the Standard for Thermal Protectors for Motors, UL 547.

B. Impedance protection complying with the requirements in the Standard for Impedance-Protected Motors, UL 519.

C. Other protection that is shown by test to be equivalent to that mentioned in item A.

Exception: A motor on which, with the motor stalled, the temperatures on the windings do not exceed the limits specified in Table 20.2, is not required to have motor-overload protection.

15.2 A motor having openings in the enclosure or frame shall be installed or shielded to prevent particles from falling out of the motor onto combustible material located within or under the assembly.

15.3 The requirement in paragraph 15.4 will necessitate the use of a barrier of noncombustible material under an open type motor unless:

A. The structural parts of the motor or the vent or chimney connector damper, such as the bottom closure, provide the equivalent of such a barrier,

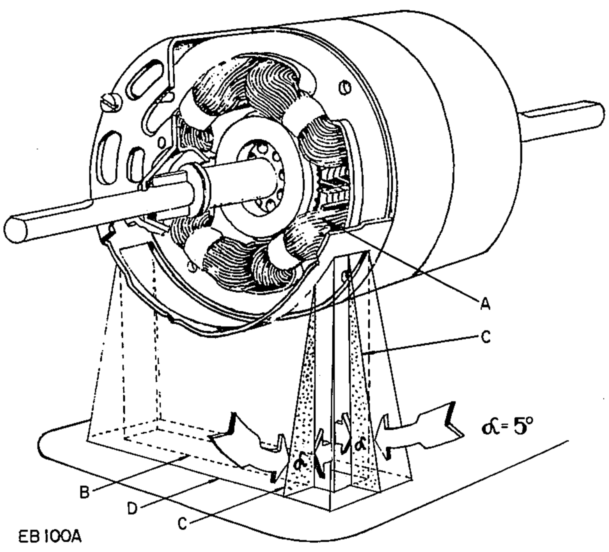
B. The motor overload-protective device provided with the motor is such that no burning insulation or molten material falls out of the enclosure when the motor is energized with the winding open-circuited,

C. The motor is provided with a thermal motor protector — a protective device that is sensitive to temperature and current — that will prevent the temperature of the motor windings from exceeding 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked, or

D. The motor complies with the requirements in the Standard for Impedance-Protected Motors, UL 519.

15.4 The barrier mentioned in paragraph 15.1 shall be located under the motor as illustrated in Figure 15.1 when the vent or chimney connector damper is installed in accordance with the manufacturer's instructions. This applies to all mounting positions of the damper assembly. The barrier shall have an area not less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier, provided that such openings would not permit molten metal, burning insulation, or the like, to fall on combustible material.

FIGURE 15.1
LOCATION AND EXTENT OF BARRIER



A —Motor winding to be shielded by barrier. This is to consist of the entire motor winding if it is not otherwise shielded, and is to consist of the unshielded portion of a motor winding that is partially shielded by the motor enclosure or equivalent.

B —Projection of outline of motor winding on horizontal plane.

C —Inclined line that traces out minimum area of the barrier. When moving, the line is to be always (1) tangent to the motor winding, (2) five degrees from the vertical, and (3) oriented so that the area traced out on a horizontal plane is maximum.

D —Location (horizontal) and minimum area for barrier. The area is to be that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

15.5 The diameter of a motor is the diameter of the circle circumscribing the stator frame measured in the plane of the laminations, excluding lugs, fins, boxes, and the like, used solely for motor mounting, cooling, assembly, or connection.

16. Insulating Material

16.1 Material for mounting a live part shall be porcelain, phenolic composition, cold-molded composition, or equivalent material.

16.2 Ordinary vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of electric shock. A thermoplastic material may be employed if found to have acceptable mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric voltage withstand, and other properties as needed for the application.

17. Spacings

General

17.1 All metal parts that may be at different potentials during the intended operation of the vent or chimney connector damper shall be separated from each other and from dead metal parts.

17.2 All uninsulated live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity and shall be judged on the basis of the highest voltage involved. See paragraph 17.4.

17.3 The spacing at wiring terminals is to be measured with appropriate wires in place and connected to the terminal as in actual service.

High-Voltage Circuits

17.4 Except as noted in paragraph 17.8 and Exception No. 2 to paragraph 17.9, spacings in an assembly shall not be less than those indicated in Table 17.1. Greater spacings may be required if the enclosure, because of its size, shape, or the material used, is not considered to be sufficiently rigid to warrant the minimum spacings.

17.5 To determine if an assembly or subassembly is within the volt-ampere limitation with respect to the spacing requirements of Table 17.1, the input voltage is to be derived from Table 18.1, and the volt-ampere consumption of the assembly or subassembly is to be added to the volt-ampere consumption of the equipment intended to be controlled. The sum of the inputs to and the switch ratings of the assembly or subassembly is the value to be used to determine if the rating is within the volt-ampere limitation. This principle applies in the case of an assembly or subassembly that does not contain a number of individual components as mentioned in paragraph 17.8, and also when individual components are judged in accordance with respect to that paragraph.

17.6 The volt-ampere equivalent of a horsepower rating is to be taken as the product of the voltage and the full-load current as specified in Table 23.2 and, in the case of a polyphase device, the appropriate numerical multiplier.

17.7 If more than one load handling component is included in one enclosure, the spacing from one component to another, and from any one component to the enclosure or other uninsulated dead metal part excluding its mounting surface, is based on the maximum voltage and total volt-ampere rating of the overall assembly and not on the individual component rating. The inherent spacings within an individual component such as a relay (including spacings from a live part to the mounting surface other than the enclosure) are judged on the basis of the volt-amperes consumed and controlled by the individual component.

TABLE 17.1
MINIMUM SPACINGS

(TS-318)

		Between Any Uninsulated Live Part and an Uninsulated Live Part of Opposite Polarity, Uninsulated Grounded Part Other Than the Enclosure, or Exposed Metal Part				Between Any Uninsulated Live Part and Walls of a Metal Enclosure Including Fittings for Conduit of of Metal-Clad Cable	
		Through Air or Oil		Over Surface		Shortest Distance	
Item	Voltage Range	Inch	(mm)	Inch	(mm)	Inch	(mm)
A. General	0—150	1/8[a,b]	(3.2)	1/4	(6.4)	1/2	(12.7)
	151—300	1/4[b]	(6.4)	3/8	(9.5)	1/2	(12.7)
	301—600	3/8[b]	(9.5)	1/2	(12.7)	1/2	(12.7)
B. Maximum Rating of 2000 Volt-Amperes	0—300	1/8[a,b]	(3.2)	1/4	(6.4)	1/4	(6.4)
C. Maximum Rating of 100 Volt-Amperes[d]	0—600	1/8[a,c] 1/16[a,f]	(3.2, 1.6)	1/4[e] 1/16[f]	(6.4, 1.6)	1/4	(6.4)
	601—1000	1/4[a,c] 3/16[a,f]	(6.4, 4.8)	3/8[e] 3/16[f]	(9.5, 4.8)	1/2	(12.7)

a The spacing between wiring terminals by which connections are to be made to the control, regardless of polarity, and between a wiring terminal and a dead metal part (including the enclosure) that may be grounded when the device is installed, shall not be less than 1/4 inch (6.4 mm).

b The spacings between uninsulated live parts of the same polarity, except at contacts, are required to be not less than 1/32 inch (0.8 mm) through air and not less than 1/16 inch (1.6 mm) over the surface of insulating material, and the construction of the parts is required to be such that these spacings will be maintained permanently. Otherwise, the spacings in a safety control shall comply with the requirements of the table.

c For the purpose of this requirement, a metal piece attached to the enclosure is considered to be a part of the enclosure if deformation of the enclosure is liable to reduce spacings between the metal piece and uninsulated live parts.

d These spacing values apply to a safety circuit connected to an isolated secondary of a 100 volt-ampere or smaller transformer. Short-circuiting of the parts involved regardless of polarity, shall not result in unsafe operation of the controlled equipment. These values apply only to spacings between components of the circuit under consideration, or between these components and dead metal — no reduction of spacings to other circuits of combination equipment is acceptable.

e Between an uninsulated live part and an exposed isolated (insulated) dead metal part.

f Between uninsulated live parts of opposite polarity and between an uninsulated live part and a grounded metal part other than the enclosure.

17.8 The inherent spacings within a component, such as a snap switch or lampholder, in other than a safety circuit, and the inherent spacings within a motor or clock motor, are judged on the basis of the requirements for the component. The spacings from such a component to another component and to the enclosure, and the spacings at wiring terminals are to be judged on the basis of the requirements in paragraph 17.4 and Table 17.1.

17.9 An insulating lining or barrier of vulcanized fiber or similar materials employed where spacings would otherwise be insufficient shall not be less than 0.028 inch (0.71 mm) thick and shall be so located or of such material that it will not be impaired by arcing, except that vulcanized fiber not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception No. 1: Thinner insulating material may be used if it has equivalent mechanical and electrical properties.

Exception No. 2: If required in place of spacings between a magnet-coil winding and other uninsulated live parts or grounded dead metal parts, the type of insulation may differ from that required, and the type and thickness of crossover-lead insulation and insulation under coil terminals secured to the coil winding may be less than that specified, provided that the coil is capable of withstanding the dielectric voltage-withstand test described in paragraphs 25.1 — 25.6 between coil-end leads after breaking the inner coil lead where it enters the layer, or an equivalent opposite polarity test.

17.10 Unless of a material as described in paragraph 16.1 or 16.2, when acceptable for sole support of uninsulated live parts, a barrier or liner shall be used in conjunction with at least 1/32 inch (0.8 mm) air space.

17.11 Mica not less than 0.013 inch (0.33 mm) thick may be used in lieu of the through air spacing indicated in Table 17.1, provided the mica is tightly held in a fixed position by the parts between which the spacing is required.

17.12 Film-coated wire is considered to be an uninsulated live part in determining compliance of an assembly with the spacing requirements.

Low-Voltage Circuits

17.13 Spacings shall be as specified in paragraphs 17.14 — 17.16 if a short circuit between the parts involved may result in impaired operation of the controlled equipment.

17.14 The spacing between an uninsulated live part and the wall of a metal enclosure, including fittings for the connection of conduit or metal-clad cable, shall not be less than 1/8 inch (3.2 mm).

17.15 The spacing between wiring terminals, regardless of polarity, and between a wiring terminal and a dead metal part, including the enclosure, that may be grounded when the device is installed, shall not be less than 1/4 inch (6.4 mm).

17.16 The spacing between uninsulated live parts, regardless of polarity, and between an uninsulated live part and a dead metal part, other than the enclosure, that may be grounded when the device is installed, shall not be less than 1/32 inch (0.8 mm), provided that the construction of the parts is such that spacings will be maintained.

17.17 Spacings for the low-voltage nonsafety circuit are not specified. Such spacings shall be judged on the basis of acceptable performance, during all applicable tests specified herein, including the dielectric strength described in paragraph 25.3.

PERFORMANCE

18. General

18.1 Representative samples of a vent or chimney connector damper, and of any subassembly shall be subjected to the applicable tests described herein. After being tested in accordance with these requirements, no part of the assembly shall indicate damage or permanent distortion that may impair the intended function of the assembly.

18.2 A vent or chimney connector damper shall be tested in the position in which it is intended to be installed as specified in the installation instructions. A vent or chimney connector damper that may be installed in several different mounting positions shall be tested in the position that is judged to be the most adverse for the particular test as specified in paragraphs 18.3 and 18.4.

18.3 The most adverse mounting position for a particular test is considered to be the one that is likely to influence the test results in the most unfavorable manner, such as by imposing a greater load on a damper drive motor or a spring or by causing higher temperatures on operating or electrical components.

18.4 If the most adverse mounting position for a vent or chimney connector damper is not definable or if different adverse conditions are introduced by different mounting positions, the tests shall be conducted in as many different positions as necessary to cover each adverse condition.

18.5 The tests shall be conducted at the rated frequency and at the voltage indicated in Table 18.1.

19. Input

19.1 The power input to a vent or chimney connector damper, any associated remote control unit, or both shall not exceed the marked rating of the control by more than 10 percent when it is operated under the conditions of intended use and with the damper, the control unit, or both connected to a supply circuit as indicated in Table 18.1.

20. Heating Test

Test Installation

20.1 The damper assembly intended for installation in the vent or chimney connector pipe is to be installed as part of a vertical or horizontal flue-pipe assembly as shown in Figures 20.1 and 20.2, respectively. The diameter of the flue pipe is to be consistent with the size of the flue-pipe connections of the vent or chimney connector damper assembly.

20.2 The determination if the vent or chimney connector damper is to be tested on a vertical or horizontal flue pipe assembly is to be made in accordance with the requirements in paragraph 18.2.

TABLE 18.1
TEST VOLTAGES

(TV-313)

	Voltage Rating of Control and Lead Terminals and Corresponding Test Potential in Volts[a]				
Test	110—120	220—240	254—277	440—480	550—600
Input	120	240	277	480	600
Heating	120	240	277	480	600
Electromagnet —					
Overvoltage, ac or dc	132	264	305	528	660
Undervoltage, ac	102	204	235	408	510
Undervoltage, dc	96	192	222	384	480
Overload	120	240	277	480	600
Endurance	120	240	277	480	600
Dielectric Voltage-Withstand	As described in text				
Volt-Ampere Capacity	120	240	277	480	600
Burnout	120	240	277	480	600

[a] If the rating of the control does not fall within any of the indicated voltage ranges, it is to be tested at its rated voltage.

20.3 The flue gas generator illustrated in Figures 20.1 and 20.2 is to be used to supply flue gases to the vertical or horizontal flue-pipe assembly in which the vent or chimney connector damper is installed. The flue gas generator is to be capable of producing flue gases at the specified test temperatures when fired at least at the inputs specified in Table 20.1.

TABLE 20.1
FLUE-GAS GENERATOR INPUTS

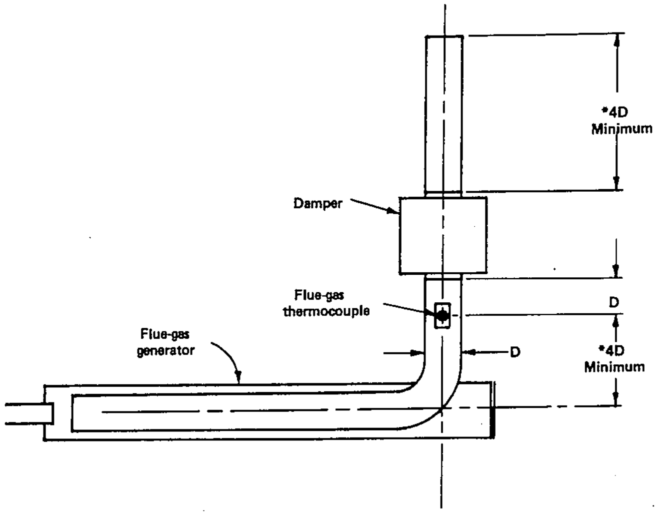
(TP-428)

Equivalent Nominal Diameter of Flue Pipe Connector, Inches	(mm)	Input to Flue-Gas Generator Btu Per Hour	(W)
6	152	48,500	13,050
7	178	65,800	19,082
8	203	86,200	24,998
9	229	109,000	31,610
10	254	135,000	39,150
12	305	195,000	56,550
14	356	264,000	76,560
16	406	345,000	100,050
18	457	436,000	126,440
20	508	539,000	165,010
22	559	652,000	199,604
24	610	776,000	237,565

20.4 The flue pipe assemblies, connected to the flue gas generator in which the vent or chimney connector damper is to be installed, are to consist of standard stove pipe sections.

20.5 A partial enclosure, consisting of two adjoining walls forming a corner, is to be placed adjacent to the vent or chimney connector damper under test, and installed in a vertical flue pipe assembly shown in Figure 20.1. A wall and adjoining ceiling are to be placed on one side and above the vent or chimney connector damper installed in a horizontal flue pipe assembly as shown in Figure 20.2. The enclosure parts simulating the walls and ceiling are to be placed from the vent or chimney connector damper at clearances to combustibles specified by the manufacturer, but not at a greater clearance than 18 inches (0.46 m) as measured from the size of the flue pipe inlet connector of the vent or chimney connector dampers.

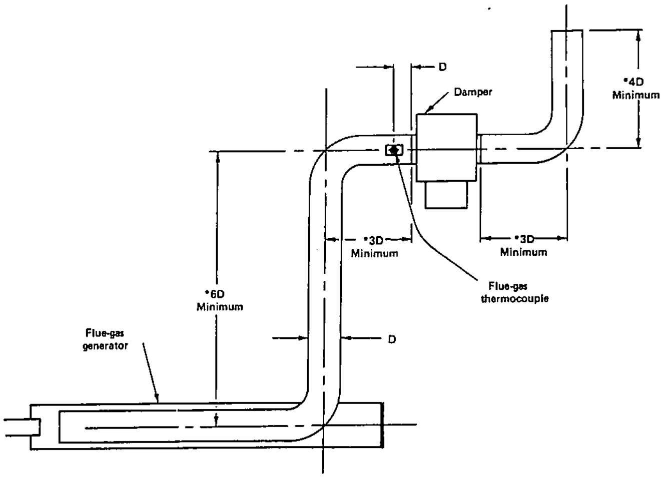
FIGURE 20.1
INSTALLATION FOR HEATING TEST ON VERTICAL
FLUE PIPE ASSEMBLY



S2146

*These dimensions are not considered critical — greater dimensions may be used.

FIGURE 20.2
INSTALLATION FOR HEATING TEST ON HORIZONTAL
FLUE PIPE ASSEMBLY



S2147

*These dimensions are not considered critical — greater dimensions may be used.

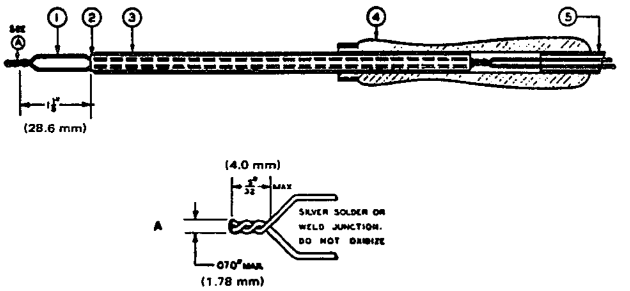
20.6 The walls and ceiling of the partial enclosure shall extend at least 3 feet (0.9 m) beyond the extreme section(s) of the vent or chimney connector damper.

20.7 The partial enclosure described in paragraphs 20.5 and 20.6 is to be constructed of 1-inch nominal thickness wood boards or plywood, 3/4-inch thick, and finished flat black at the side facing the test sample.

Temperature Measurements on Other Than Electrical Parts

20.8 The flue-gas temperature is to be measured by a thermocouple, such as illustrated in Figure 20.3, inserted into the vertical or horizontal section of flue pipe as shown in Figures 20.1, 20.2, and 20.4 at a level one flue-pipe diameter below or upstream from the connection to the test device.

FIGURE 20.3
THERMOCOUPLE FOR FLUE-GAS TEMPERATURE



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1. No. 20 AWG (0.51 mm^2) iron-constantan, or woven-glass-covered thermocouple wires extending from hot junction to potentiometer or reference junction.

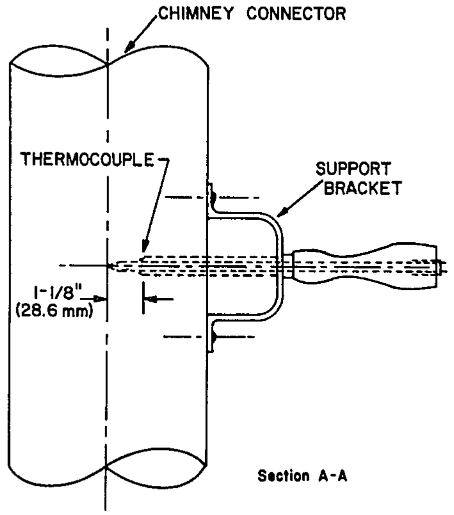
2. 1 — Leeds & Northrup Standard 714B, or equal, 1/4 inch (6.4 mm) outside diameter of 2-hole porcelain insulator cut to length and ends beveled on two sides.

3. 1 — 5/16 inch (7.9 mm) outside diameter by 0.032 inch (0.81 mm) wall tubing. Ream, if necessary, to fit over insulator; then crimp ends over beveled ends of insulator.

4. 1 — Small wooden handle.

5. 1 — Piece of rubber tubing, approximately 5/16 by 3/32 by 2 inches long (7.9 by 2.4 by 50.8 mm long).

FIGURE 20.4
TEST SETUP FOR A STACK-MOUNTED CONTROL



S 2700

20.9 A temperature other than the flue-gas temperature is to be measured by a thermocouple not heavier than No. 24 AWG (0.21 mm^2). The temperature attained by a part of the vent or chimney connector damper is to be obtained by means of a thermocouple applied to assure positive thermal contact with the part. Such a thermocouple is to be located at a point attaining maximum temperatures. Additional thermocouples may be placed at other locations as deemed necessary.

20.10 The ambient temperature is to be determined by the use of a shielded thermocouple located at the elevation of the horizontal axis of the flue-gas generator and is to be on a vertical line located 24 inches (610 mm) horizontally from one wall of the test structure.

20.11 The measurements of temperature rises on the vent or chimney connector damper parts and on the test structure are to be referenced to the recorded ambient temperatures as determined by paragraph 20.10.

20.12 A thermocouple is to be attached to a metal surface by silver soldering, brazing, or welding of the tip (junction) to the metal surface.

20.13 A thermocouple is to be secured to a wood surface by staples placed over the insulated portion of the wires. The 1/2 inch (12.7 mm) length of thermocouple tip is to be depressed flush with the wood surface at the point of measurement and held in thermal contact with the surface at that point by pressure-sensitive tape.

20.14 The wiring methods for thermocouple circuitry including junctions, terminals, switches, plugs, and jacks shall be such as to provide independent continuous routing of both thermocouple leads to the recording equipment.

Temperature Measurement on Electrical Components, Thermocouple Method

20.15 Temperatures of electrical components are to be measured by thermocouples, except that the change-in-resistance method may be used to measure the temperature of motor windings or of coils. The thermocouples are to consist of No. 24 — 30 AWG (0.21 — 0.05 mm^2) wires. The thermocouple wire is to conform to the requirements for special thermocouples as listed in the table of limits of error of thermocouples in the Standard for Temperature-Measurement Thermocouples, ANSI MC96.1-1982.

20.16 A thermocouple junction and adjacent thermocouple lead wires are to be securely held in positive thermal contact with the surface of the material the temperature of which is being measured. In most cases, thermal contact will result from taping or cementing the thermocouple in place, but where a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

20.17 If thermocouples are used in the determination of temperatures in connection with the heating of electrical equipment, it is common practice to employ thermocouples consisting of No. 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of indicating instrument whenever referee temperature measurements by means of thermocouples are necessary.

20.18 If the temperature of a motor winding or coil is to be determined by the resistance method, the following formula shall be used:

$$T = \frac{R}{r} (k + t_1) - k + t_2)$$

in which:

T = temperature rise in degrees C,
R = resistance of the coil in ohms at the end of the test,
r = resistance of the coil in ohms at the start of the test,
t_1 = room temperature in degrees C at the start of the test,
t_2 = room temperature in degrees C at the end of the test, and
k = 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum. Values of the constant for other grades must be determined.

20.19 If it is necessary to de-energize the winding before measuring R, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to give the value of R at shutdown. The motor or coil winding is to be at room temperature at the start of the test.

Test Method

20.20 The vent or chimney connector damper and any associated remotely connected control subassembly, if provided, are to be energized at the test voltage specified in Table 18.1 for the corresponding voltage rating. Electrical loads that will cause maximum rated current to flow through the current-carrying components are to be connected to the load terminals. Before starting the test, the load-carrying contacts are to be opened and closed under load a minimum of three times.

20.21 The connections to the vent or chimney connector damper and the remote control assembly are to be made with conductors of a size as required for 60°C (140°F) rated wire.

Exception: If the marking specifies the use of a wire size with a temperature rating higher than 60°C in accordance with paragraphs 33.3 and 33.4, the connections are to be made with the wire size specified in the marking.

20.22 The vent or chimney connector damper and the remote control assembly are to be operated under the conditions specified in paragraphs 20.24 and 20.25 until constant temperatures are observed on all parts. The temperature rises shall not exceed the values specified in Table 20.2.

20.23 With respect to paragraph 20.22, a temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minutes, indicate no change.

Assembly Intended for Installation in Flue Pipe System

20.24 With the vent or chimney connector damper installed as described in paragraphs 20.1 — 20.7, the flue gas generator is to be fired at an input rate not less than that specified in Table 20.1 for the corresponding diameter of the flue pipe connector of the damper assembly. The temperature of the flue gases entering the vent or chimney connector damper is to be maintained at the maximum rated flue gas temperature marked on the vent or chimney connector damper, as determined by the flue gas thermocouple located as shown in Figures 20.1 and 20.2, but not lower than 378°C (680°F) above the room temperature. A vent or chimney connector damper that has no marked rating for maximum flue gas temperature is to be tested with the flue gas temperature of 517°C (930°F) above the room temperature.

Remote Control Assembly

20.25 A remotely wired control subassembly is to be tested in the ambient temperature specified by the manufacturer. See paragraph 33.2.

TABLE 20.2
MAXIMUM TEMPERATURE RISES

(TT-128)

	Degrees	
Device or Material	C	F
A. COMPONENTS		
1. Capacitors		
Electrolytic type	40	72
Other types[f]	65	117
2. Fuses:		
Class G, J, L, T, and CC:		
Tube	100	180
Ferrule or blade	85	153
Others[f]	65	117
3. Contacts, buses, and connecting bars[d]	65	117
4. Sealing compounds	Maximum Temperature 15°C (27°F) less than its melting point	
5. Field-wiring terminals	50	90
6. Points on or within a terminal box or compartment on which conductors to be connected to the control may rest[a]	36	63
7. Transformer enclosures		
a. Class 2 transformer enclosure	60	108
b. Power transformer enclosure	65	117
B. INSULATION SYSTEMS		
1. Class 105 insulation systems on windings of a relay, a solenoid,and the like:[e]		
Thermocouple method	65	117
Resistance method	85	153
2. Class 130 insulation systems on windings of a relay, a solenoid, and the like:[e]		
Thermocouple method	85	153
Resistance method	105	189
3. Class 130 insulation systems on vibrator coils:[e]		
Thermocouple or resistance method	95	171

(Continued)

TABLE 20.2(Cont'd)
MAXIMUM TEMPERATURE RISES

(TT-128)

	Degrees	
Device or Material	C	F
4. Class A insulation system on coil windings of a d-c motor and of a universal motor:[e]		
a. In an open motor:		
Thermocouple method	65	227
Resistance method	75	135
b. In a totally enclosed motor:		
Thermocouple method	70	126
Resistance method	80	144
5. Class A insulation systems on coil windings of an a-c motor not including a universal motor, and on a vibrator coil:[e,i]		
a. In an open motor and on a vibrator coil:		
Thermocouple or resistance method	75	135
b. In a totally enclosed motor:		
Thermocouple or resistance method	80	144
6. Class B insulation systems on coil windings of a d-c motor and of a universal motor:[e]		
a. In an open motor:		
Thermocouple method	85	153
Resistance method	95	171
b. In a totally enclosed motor:		
Thermocouple method	90	162
Resistance method	100	180
7. Class B insulation systems on coil windings of an a-c motor not including a universal motor:[e,i]		
a. In an open motor:		
Thermocouple or resistance method	95	171
b. In a totally enclosed motor:		
Thermocouple or resistance method	100	180

(Continued)

TABLE 20.2(Cont'd)
MAXIMUM TEMPERATURE RISES

(TT-128)

	Degrees	
Device or Material	C	F
C. INSULATED CONDUCTORS		
1. Appliance wiring material		
75°C rating	50	90
80°C rating	55	99
90°C rating	65	117
105°C rating	80	144
200°C rating	175	315
250°C rating	225	405
2. Other types of insulated wires	See Note c	
3. Wire, Code[b]		
Types RF, FF, RUW	35	63
Types RH, RFH, FFH, RHW, THW, THWN	50	90
Types T, TF, TFF, TW	35	63
Type TA	65	117
D. INSULATING MATERIALS		
1. Fiber employed as electrical insulation	65	117
2. Phenolic composition employed as electrical insulation or as a part the deterioration of which would result in a risk of fire or electric shock[b]	125	225
3. Varnished-cloth insulation	60	108
E. METALS		
1. Carbon steel sheet, cast iron	517	930
2. Aluminum alloys		
1100	183	330
3003	239	430
2014, 2017, 2024, 5052	294	530
3. Aluminum-coated steel[g]	656	1180
4. Stainless steel		
Types 302, 303, 304, 321, 347	686	1235
Type 316	711	1280
Type 309S	861	1550
Types 310, 310B	911	1640
Type 446	911	1640
5. Galvanized steel[h]	267	480
6. Carbon steel — coated with Type A19 ceramic	572	1030

(Continued

TABLE 20.2(Cont'd)
MAXIMUM TEMPERATURE RISES

(TT-128)

Device or Material	Degrees C	F
F. ADJACENT COMBUSTIBLES		
1. Test enclosure	65	117

a The temperature rise observed on the terminals and at points within a terminal box may exceed the values specified, provided the control is marked in accordance with paragraphs 33.3 and 33.4. The wiring shall not attain a temperature higher than 90°C (194°F).

b The limitation on phenolic composition and on rubber and thermoplastic insulation does not apply to compounds that have been investigated and found acceptable for use at higher temperatures.

c For standard insulated conductors other than those mentioned, references should be made to the National Electrical Code, ANSI/NFPA 70-1987; and the maximum temperature rise in any case shall not be more than the rated temperature limit of the wire in question minus 25°C (77°F).

d Contacts of silver or a silver alloy in a control that is intended to function where a high ambient temperature prevails are acceptable without any additional tests if they do not attain a temperature higher than 100°C (212°F) where the control is tested at the ambient temperature in question. If the contacts attain a temperature higher than 100°C but not higher than 150°C (302°F) they are required to withstand, with acceptable results, overload and endurance tests conducted at the high ambient temperature in question.

e At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may be more than the maximum acceptable temperature rise specified in this table provided the temperature rise as measured by the resistance method is not more than that specified. The temperature rise measured by means of thermocouples may exceed the specified value by:

	Additional Temperature Rise	
Item B	°C	°F
Subitems 1, 2, and 3 and part a of subitem 4	15	27
Part a of subitem 5	5	9
Part a of subitem 6	20	36
Part a of subitem 7	10	18

f A capacitor or a fuse that has been investigated and found acceptable at a higher temperature may be used at that temperature.

g When the reflectivity of aluminum-coated steel is utilized to reduce the risk of fire, the maximum temperature rise shall be (461°C) 830°F.

h The specified maximum temperature rises apply when the galvanizing is required as a protective coating or the reflectivity of the surface is utilized to reduce the risk of fire.

i These temperature rises apply only to a motor having a frame diameter of 7 inches or less. See paragraph 15.5.

21. Special Heating Test

21.1 The test described in paragraphs 21.2 and 21.3 is to be conducted only on a damper assembly that does not include a time delay for closing in accordance with paragraph 5.7 or that includes a time delay less than 3 minutes.

21.2 The damper assembly is to be installed in accordance with the manufacturer's instructions on the vent or chimney connector pipe of an oil-fired heating appliance. All four vertical walls and the bottom of the combustion chamber of the heating appliance are to be lined with a refractory brick. The appliance is to be equipped with an oil burner capable of firing at the maximum input rate recommended by the appliance manufacturer. The oil burner is to employ a cadmium sulphide type ("cad cell") combustion detector, mounted on the oil line inside the burner blast tube at the location specified by the burner manufacturer, and a burner-mounted primary safety control and ignition transformer. Thermocouples are to be placed at the face of the cadmium sulphide cell of combustion detector wiring located on the burner, parts of the ignition transformer and primary safety control, and on all other parts of the burner as deemed necessary.

21.3 With the blade of the damper assembly in a fully open position, the oil burner is to be fired at the maximum recommended rate for at least 2-1/2 hours. After this time the burner is to be shut off and the damper blade permitted to assume a closed position. Temperatures on parts of the burner as specified in paragraph 21.2 are to be monitored and all temperatures shall be within the limits for the parts involved in accordance with Table 20.2.

22. Increased and Undervoltage Tests

22.1 An electromagnet used in a vent or chimney connector damper or in a remote control assembly shall continuously withstand 10 percent above its rated voltage without damage to the operating coil and operate successfully at (1) 20 percent, if for use on dc, or (2) 15 percent, if for use on ac, less than rated voltage. An assembly having a voltage rating within one of the ranges specified in Table 18.1 shall be tested at the test voltage specified in that table. See paragraphs 18.2 — 18.4.

22.2 For operation at minimum voltage, the coil is to be subjected to the intended high-voltage until equilibrium temperature is reached and then tested immediately for closing at the minimum voltage.

23. Overload Test

23.1 All contacts of an automatically operated switch, relay, contactor, and the like, used in a vent or chimney connector damper or in a remote control assembly, shall be tested for their maximum load ratings. Operation of the device shall not be impaired, nor shall there be undue burning, pitting, or welding of the contacts.

23.2 During the test, the sample is to be in the maximum rated ambient temperature specified by the manufacturer but not less than the ambient temperature that will result in approximately the same temperature on the components determined by a test conducted as described in paragraph 20.24. See paragraphs 18.2 — 18.4.

23.3 All overload tests shall be made at the fastest rate permitted by the vent or chimney connector damper when it is operated as intended, but not faster than 6 cycles per minute, unless specifically authorized by the manufacturer. For each cycle the load circuit shall be energized for at least 1 second.

23.4 An ampere-rated switch not intended for controlling a motor shall perform acceptably when subjected to an overload test consisting of making and breaking for 50 cycles of operation, at the specified rate a current of 150 percent of the rated value, at the voltage indicated in Table 18.1.

23.5 Except as noted in paragraphs 23.8 and 23.9, a switch intended for full-voltage motor starting shall perform acceptably when subjected to a locked-rotor test consisting of making and breaking for 50 cycles of operation, at the specified rated current as described in Table 23.1, and at the voltage indicated in Table 18.1.

23.6 A switch intended for controlling a pilot-duty load shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking a circuit of rated frequency and 110 percent of the voltage indicated in Table 18.1, at the rate specified in paragraph 23.3, with the contacts closed for approximately 1 second during each cycle. The load is to consist of an electromagnet representative of the magnet-coil load that the switch is intended to control, the normal current to be determined from the voltage and volt-ampere rating of the contacts. The test coils are to be those described in paragraph 24.5. The test is to be conducted with the contactor free to operate, that is, not blocked in either the open or closed position.

TABLE 23.1
METHOD OF DETERMINING CURRENTS FOR OVERLOAD TESTS

(TC-309-1)

Device Rated in	Current in Amperes for Overload Test Described in Paragraph Indicated Locked Rotor Test[a]	 150 Percent Current Test[b]
Horsepower (kW)	AC: Six times the full-load current indicated in Table 23.2	AC: 1.5 times the full-load current indicated in Table 23.2
Full-load and locked-rotor amperes	Rated locked-rotor amperes	1.5 times rated full-load amperes

a Paragraphs 23.5, 23.8.

b Paragraphs 23.8, 23.9.

23.7 A switch that has been tested and found acceptable for controlling an ac motor is acceptable for ac pilot duty without further overload or endurance tests provided that:

A. During the locked-rotor motor controller test, the contacts are caused to make and break, for 50 cycles of operation at a rate specified in paragraph 23.3, a current having a value as indicated in the second column of Table 23.1 at a power factor of 0.5 or less; and

B. The pilot-duty inrush current at the same voltage is not more than 67 percent of (1) the rated locked-rotor motor current of the device, or (2) the locked-rotor current corresponding to the horsepower rating, depending on the basis on which the switch is rated.

23.8 A switch that is not intended primarily to make and break motor current under locked-rotor conditions, but that has a manual adjusting or regulating means that may cause it to be so used, shall comply with the requirements in (1) paragraph 23.5 for a locked-rotor test, conducted at intervals of 30 seconds, and (2) paragraph 23.9 pertaining to the 150 percent overload test.

23.9 A switch that may make a motor circuit under locked-rotor conditions, but that will not be called upon to break the circuit under such conditions, shall perform acceptably when subjected to an overload test consisting of 50 cycles of making and breaking, at a rate specified in paragraph 23.3, a current as indicated in the third column of Table 23.1. The voltage of the test circuit is to have the value indicated in Table 18.1. The switch shall also be subjected to the locked-rotor test described in paragraph 23.5, except that it is to make, not break, the circuit only.

23.10 If an ampere-rated switch has the same ampere rating at more than one voltage, a test at the highest voltage is considered to be representative of tests at the lower voltages; but if the switch has a greater ampere rating at the lower voltage than at the higher ones, tests shall be made at the highest and lowest voltages.

23.11 If a horsepower-rated switch has more than one voltage rating, the overload test or tests shall cover the conditions of maximum voltage, power, and current. A separate switch is to be used for testing each condition.

23.12 A current-interrupting control for use on ac shall be tested with an inductive load.

23.13 The power factor of an inductive load shall be 0.75 — 0.80, except that it shall be 0.40 — 0.50 for a load simulating locked-rotor conditions in a motor, and shall not be more than 0.35 for a pilot-duty load (steady state).

23.14 Table 23.2 includes full-load currents corresponding to motor horsepower ratings, and is to be used in determining loads for the various tests specified for horsepower-rated equipment.

23.15 All current-interrupting tests are to be made at the voltage indicated in Table 18.1. The open-circuit voltage of the supply circuit is to be not less than 100 percent nor more than 105 percent of the specified test voltage, except that a higher voltage may be employed if agreeable to those concerned. The ampacity of the supply circuit is to be such that the closed-circuit voltage with rated current flowing is within 2-1/2 percent of the specified test voltage.

23.16 For a grounded-neutral system, the enclosure is to be connected during the test through a 3-ampere cartridge fuse to the grounded conductor of the circuit. For any other system, the enclosure is to be connected through such a fuse to the live pole least likely to strike (arc) to ground. The fuse shall not open during the test.

24. Endurance Test

24.1 A vent or chimney connector damper and its associated remote control assembly, if used, shall be subjected to 100,000 cycles of operation. Each operation is to consist of causing the damper blade to go to a fully closed and then to a fully open position in the intended manner. During the test, the electrical load-handling components shall be connected to maximum rated loads. Operation of the switch shall not be impaired, nor shall there be undue burning, pitting, or welding of the contacts.

24.2 The test shall be conducted on the sample which was first subjected to the overload test.

24.3 The conditions for the test shall be as described in paragraphs 23.2, 23.3, 23.10, 23.11, 23.15, and 23.16. The characteristics of the electrical loads shall be in accordance with paragraphs 24.4 and 24.5.

24.4 Switch contacts intended to control an electrical load are to be caused to make or break the rated current at the voltage specified in Table 18.1. Switch contacts for control of a motor are to be tested with full-load motor current. If the rating is given in horsepower, the full load current is to from Table 23.2.

TABLE 23.2
FULL-LOAD MOTOR-RUNNING CURRENTS IN AMPERES
CORRESPONDING TO VARIOUS A-C HORSEPOWER
(kW OUTPUT) RATINGS

(TC-401-1)

		110—120 Volts			220—240 Volts			440—480 Volts		550—600 Volts	
Horsepower	(kW)	Single-Phase	Two-Phase	Three-Phase	Single-Phase	Two-Phase	Three-Phase	Two-Phase	Three-Phase	Two-Phase	Three-Phase
1/10	0.08	3.0	—	—	1.5	—	—	—	—	—	—
1/8	0.09	3.8	—	—	1.9	—	—	—	—	—	—
1/6	0.13	4.4	—	—	2.2	—	—	—	—	—	—
1/4	0.19	5.8	—	—	2.9	—	—	—	—	—	—
1/3	0.25	7.2	—	—	3.6	—	—	—	—	—	—
1/2	0.37	9.8	4.0	4.0	4.9	2.0	2.0	1.0	1.0	0.8	0.8
3/4	0.56	13.8	4.8	5.6	6.9	2.4	2.8	1.2	1.4	1.0	1.1
1	0.75	16.0	6.4	7.2	8.0	3.2	3.6	1.6	1.8	1.3	1.4
1-1/2	1.12	20.0	9.0	10.4	10.0	4.5	5.2	2.3	2.6	1.8	2.1
2	1.49	24.0	11.8	13.6	12.0	5.9	6.8	3.0	3.4	2.4	2.7
3	2.24	34.0	16.6	19.2	17.0	8.3	9.6	4.2	4.8	3.3	3.9
5	3.73	56.0	26.4	30.4	28.0	13.2	15.2	6.6	7.6	5.3	6.1

24.5 A switch intended for pilot duty shall perform acceptably when operated for the number of cycles indicated in paragraph 24.1, making and breaking a circuit of rated frequency and at the voltage indicated in Table 18.1. The load is to consist of an electromagnet representative of the magnet-coil load intended to be controlled. The test current is to be determined from the voltage and volt-ampere rating of the control; and for an ac rating, the power factor is to be 0.35 or less (steady state) and the inrush current shall be ten times the test current. The test is to be conducted with the contactor free to operate, that is, not blocked either open or closed.

24.6 If a device requiring an endurance test of 100,000 cycles has two or more electrical ratings (that is, different currents at different voltages) that are approximately equal in volt-amperes, it may be tested for not less than 25,000 cycles at each rating, but the total number of cycles on any one sample shall be not more than 100,000 cycles. At least one sample, however, shall be tested for a total of 100,000 operations.

25. Dielectric Voltage-Withstand Test

25.1 High-voltage portions of a damper shall withstand for 1 minute without breakdown the application of a 60 hertz potential of 1000 volts plus twice maximum rated voltage of the circuits involved.

A. Between uninsulated high-voltage live parts and grounded or exposed metal parts or the enclosure with the contacts open and closed.

B. Between high-voltage terminals of opposite polarity with the contacts closed,

C. Between uninsulated high-voltage live parts and components of circuits included under Item C in Table 17.1 or as low voltage,

D. Between uninsulated metal parts of one high-voltage circuit and such parts of another high-voltage circuit, and

E. Between uninsulated live parts of a circuit included under Item C of Table 17.1 and components of any other circuit.

25.2 A damper employing an isolated limited secondary circuit shall withstand for 1 minute without breakdown the application of an alternating potential of 1000 volts plus twice the maximum rated secondary voltage, at rated frequency, between all uninsulated live parts connected to the secondary circuit and grounded dead metal parts. All chassis grounds of the secondary circuit, if any, are to be disconnected prior to applying the dielectric voltage-withstand potential in a manner so that there will be no breakdown to ground at the point(s) normally connected to ground.

25.3 A damper employing a low-voltage circuit shall withstand for 1 minute without breakdown the application of a 60 hertz potential of 500 volts applied between uninsulated low-voltage live parts of opposite polarity with contacts, if any, closed, and between uninsulated low-voltage live parts and the enclosure and grounded dead metal parts.

25.4 A Class 2 transformer shall withstand without breakdown, for a period of 1 minute, the application of an alternating potential of 1000 volts plus twice the maximum rated primary voltage, at rated frequency, between primary and secondary windings and between the primary winding and the core or enclosure.

25.5 A power transformer shall withstand without breakdown, for a period of 1 minute, the application of an alternating potential of 1000 volts plus twice the maximum rated primary or secondary voltage, at rated frequency, between primary and secondary windings, and shall withstand under the same conditions the application of an alternating potential of 1000 volts plus twice the rated voltage of each winding, at rated frequency, between each winding and the core or enclosure.

Exception: The test between primary and secondary windings is not required in the case of an autotransformer.

25.6 A 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and which can be varied, is to be used to determine compliance with the requirements in paragraphs 25.1 — 25.5. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at that value for 1 minute.

Exception: A 500 volt-ampere or larger transformer need not be used if the high potential testing equipment used is such that it maintains the specified high potential voltage at the equipment during the test.

26. Volt-Ampere Capacity Test

26.1 An isolated limited secondary circuit shall have a continuous use capacity of 100 volt-amperes or less when energized from a circuit of rated frequency at the voltage specified in Table 18.1, as determined in accordance with paragraph 26.2 or 26.3, whichever is applicable.

26.2 A single-wound secondary transformer is to attain a temperature rise on the enclosure, core, or coil of at least 50°C (90°F) when the secondary is loaded to the maximum output obtainable or 100 volt-amperes, whichever is less.

26.3 Each secondary winding of a multisecondary transformer is to be loaded in turn with a variable resistor. Starting with a cold transformer for each part of the test, the load resistance is decreased from open-circuit to short-circuit in such a manner that the lapsed time is between 1-1/2 and 2-1/2 minutes. Depending upon the open circuit voltage of the winding, the maximum outputs obtained by this method are to be as follows:

A. 350 volt-amperes for 0 — 15 volts.

B. 250 volt-amperes for 15.1 — 30 volts.

C. 200 volt-amperes for 30.1 — 1000 volts.

27. Burnout Test

27.1 There shall be no damage to the enclosure nor emission of flame or molten metal when a power transformer is operated as described in paragraphs 27.2 and 27.3.

Exception: This requirement does not apply to a transformer supplying a low-voltage, electronic, or isolated limited secondary circuit. See paragraph 27.4.

27.2 The damper is to be operated continuously at rated frequency and the voltage indicated in Table 18.1 with the enclosure grounded. The load connected to the output terminals shall be a resistance of such value that three times full-rated current will be drawn from the secondary winding of the transformer. The transformer is to be energized until constant temperature is indicated on the enclosure or until burnout occurs.

27.3 The circuit on which the transformer is tested is to be protected by fuses rated at least ten times the primary current rating of the transformer, and blowing of the fuses is not considered to be impaired operation. The test is to be conducted with the output terminals short-circuited, if such a condition results in less than three times full rated current being drawn from the secondary. If another means of limiting the load to less than three times intended is inherent in or provided as part of the device, these features are to be considered and the burnout test made at the maximum load permitted by the limiting features.

27.4 A transformer supplying a low-voltage circuit, as described in item B of paragraph 3.6 shall be tested as a standard Class 2 transformer in accordance with the requirements in the Standard for Specialty Transformers, UL 506, with low-voltage wiring terminals short-circuited, and wiring not complying with the requirements in paragraph 10.2 short-circuited. A transformer supplying an isolated limited secondary circuit as described in item D of paragraph 3.6, or an electronic circuit, shall be tested as described in paragraphs 27.2 and 27.3, except that all secondary windings are to be directly short-circuited. If a portion of an isolated limited secondary or electronic circuit is connected to low-voltage field wiring terminals, separate samples are to be subjected to the standard Class 2 test as specified above and the shorted secondary test.

28. Mercurous-Nitrate Immersion Test

28.1 Drawn or machined brass parts made of copper alloy containing more than 15 percent zinc, shall withstand total immersion for 30 minutes without cracking, in an aqueous mercurous-nitrate solution containing 10 grams of mercurous nitrate and 10 milliliters of nitric acid (specific gravity 1.42) per liter of solution.

28.2 Instructions for the preparation of solutions and procedures for replenishment, together with descriptions for cleaning and degreasing of samples, are covered in the Mercurous Nitrate Test for Copper and Copper Alloys, ASTM B154-87.

28.3 A test sample shall be subjected to the physical stresses imposed on or within a part as the result of assembly with other components of the strainer, or with tubing or piping. Such stresses shall be applied to the sample prior to and be effective during the test.

28.4 Testing with mercury is a definite risk to health and it is recommended that equipment for the removal of mercury vapor produced in volatilization be provided. Rubber gloves should be used during testing.

29. Permanence of Marking

29.1 A marking that is required to be permanent shall be molded, die-stamped, paint-stencilled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive that, upon investigation, is found to be acceptable for the application. Ordinary usage, handling, storage, and the like of a product are considered in the determination of the permanence of a marking.

29.2 Unless it has been investigated and found to be acceptable for the application, a pressure-sensitive label or a label that is secured by cement or adhesive and that is required to be permanent shall comply with the requirements in the Standard for Marking and labeling systems, UL 969.

MANUFACTURING AND PRODUCTION TESTS

30. Dielectric Voltage-Withstand Test

30.1 Each damper employing a high-voltage circuit shall withstand for 1 minute without electrical breakdown, as a routine production-line test, the application of a 60 hertz potential of 1000 volts plus twice rated voltage between high-voltage parts and dead metal parts.

Exception: The time of application of the potential may be reduced to 1 second if the value of the test potential is 120 percent of that specified.

30.2 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic reject feature of any unacceptable unit.

30.3 If the output of the test equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

30.4 If the output of the test equipment transformer is 500 volt-amperes or larger, the test potential may be indicated by (1) a voltmeter in the primary circuit or in a tertiary winding circuit, (2) a selector switch marked to indicate the test potential, or (3) a marking in a readily visible location to indicate the test potential of equipment having a single test potential output. If marking is used without an indicating voltmeter, the equipment shall include a positive means, such as a power-on lamp to indicate that the manually reset switch has been reset following a tripout.

30.5 Test equipment other than that described in paragraphs 30.2 — 30.4 may be used if found to accomplish the intended factory control.

31. Interlock Test

31.1 Each vent or chimney connector damper assembly shall be tested, as a routine production-line test to determine that the interlock required by paragraph 5.8 functions to close the circuit to the oil burner only when the damper blade is in a fully open position. If applicable, the test is to be conducted in conjunction with a remote control unit.

RATING

32. Details

32.1 A vent or chimney connector damper and an associated remote control assembly, if provided, shall be rated as specified in paragraphs 32.2 — 32.5.

32.2 An assembly intended to control an inductive load shall be rated in amperes, volts, and frequency.

32.3 An assembly intended to control a pilot duty load shall be rated in volt-amperes, volts, and frequency. As an alternate to volt-amperes, the rating may be in amperes, indicating both the in-rush and the sealed value. The current values shall be used for pilot duty rating if the in-rush current rating is different from ten times the sealed value. The pilot duty rating shall be identified by the words "pilot duty."

32.4 If the vent or chimney connector damper is intended to control an ignition transformer in conjunction (in parallel) with another load, the ignition transformer rating shall be identified separately from the other load. Such a rating shall be identified by volts, amperes, or volt-amperes, and frequency and by the words "ignition" or "ignition transformer."

32.5 An assembly intended for use with a motor shall be rated also in accordance with one of the following:

A. Rated in horsepower only,

B. Rated in horsepower and, in addition, in full-load and locked-rotor current, provided the relationship between the three values is in accordance with that specified in Tables 23.1 and 23.2, or

C. If the assembly is intended to control a motor rated 2 horsepower (1.49 kW output) or less, rated in full-load current that need not correspond with that in Table 23.2, and in locked-rotor current six times the rated full-load current. These current ratings need not be accompanied by a horsepower rating. The control may be marked with a lesser locked-rotor current rating, but tests shall be conducted at the values indicated above.

MARKING

33. Details

33.1 The following information shall appear on each vent or chimney connector damper assembly:

A. The manufacturer's name or identifying symbol.

B. A distinctive catalog number, and model number or equivalent.

C. Electrical ratings in accordance with paragraphs 32.2 — 32.5.

D. The maximum flue gas temperature, if less than 538°C (1000°F), of the appliance on which the assembly is intended to be installed.

E. Minimum clearances to combustible construction in integral inches.

F. Instructions that the assembly is for installation only on oil-fired equipment.

G. The word "WARNING" and a cautionary statement as follows or an equivalent:

> "Risk of fire if improperly installed. Do not install on a flue pipe serving to vent more than one appliance. See installation instructions for proper installation."

H. A statement to the effect that the damper blade must be in the open position when the burner is operating.

I. If the vent or chimney connector vent damper is for use with a remotely connected control unit, a statement shall be included on the vent or chimney connector damper that it is for use only with that control unit, identifying the part number, catalog number, or other equivalent distinctive designation of the control unit.

J. If the vent or chimney connector damper is shipped in two subassemblies that are intended to be joined in the field to form one assembly, each subassembly shall include a statement to the effect that is for use only with the other subassembly, identifying the other subassembly by its distinctive designation that shall be marked on that subassembly. Each subassembly shall also be marked with the manufacturer's name.

K. The date of manufacture, which may be in code.

L. An assembly intended for field wiring shall be marked in accordance with either item 1 or item 2, as appropriate, or with an equivalent statement. The marking shall be independent of any marking on the terminal connectors, shall be visible during and after installation of the assembly, and shall be as follows:

1. "Use Copper Conductors Only" or "Use Copper or Copper-Clad Aluminum Conductors Only" if the assembly is into intended for field connection with aluminum wire.

2. "Use Copper or Aluminum Conductors" or "Use Copper, Copper-Clad Aluminum, or Aluminum Conductors" if the assembly is intended for field connection with either copper or aluminum wire.

M. An assembly that is provided with fittings for use on only one type of wiring system shall be marked where it will be visible during installation to indicate the applicable wiring system.

33.2 A remote control unit, if provided, shall include the markings specified in items A, B, C, J, K, and L of paragraph 33.1 and required by paragraph 33.3. Also, it shall be marked with maximum ambient temperature rating if the manufacturer intends that the control unit may be used in higher than 25°C (77°F).

33.3 If any point within a terminal box or wiring compartment of a unit in which field-installed conductors are intended to be connected, including such conductors themselves, attains a temperature rise more than 35°C (63°F) during the temperature test, the assembly shall be marked in accordance with paragraph 33.4. The statement shall be legible and so located that it will be visible during and after installation of the supply wiring connections.

33.4 The marking mentioned in paragraph 33.3 depends on the size and temperature rating of the supply conductors employed for the test involved. The temperature value shall be in accordance with Table 33.1, and the marking shall be as follows:

A. If all the conductors used in the test were of the same size, the marking is to be "For supply connections use No.____ AWG or larger wires acceptable for at least ____°C (____°F)" or with an equivalent statement.

B. If conductors of more than one size were used in the test because of unbalanced loads or other reason, the marking is to be "For supply connections, use wires acceptable for at least ____°C (____°F). See wiring diagram for wire size" or an equivalent statement.

Exception: The conductor size need not be indicated if the temperature test was conducted with No. 14 AWG (2.1 mm^2) wires. See paragraph 20.21.

TABLE 33.1
TEMPERATURE FOR MARKING

(TT-509)

Temperature Rises During Test at Points Within Terminal Box or Compartment, or on Wires Intended for Supply Connections, Degrees C (F)		Temperature Marking, Degrees C (F)	
36—50	(64.8—90)	75	(167)
51—65	(91.8—117)	90	(194)

33.5 If a manufacturer produces or assembles vent or chimney connector dampers at more than one factory, each finished damper shall have a distinctive permanent marking by means of which it may be identified as the product of a particular factory.

33.6 A required marking shall be permanent and legible and shall be located on a permanent part of the damper. See Section 29.

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are judged include the following:

Title of Standard — UL Standard Designation

Attachment Plugs and Receptacles — UL 498
Extruded Insulated Tubing — UL 224
Flexible Cord and Fixture Wire — UL 62
Fuseholders — UL 512
Impedance-Protected Motors — UL 519
Insulating Tape — UL 510
Marking and Labeling Systems — UL 969
Motors, Electric — UL 1004
Polymeric Materials — Fabricated Parts — UL 746D
Polymeric Materials — Long Term Property Evaluations — UL 746B
Polymeric Materials — Short Term Property Evaluations — UL 746A
Polymeric Materials — Use in Electrical Equipment Evaluations — UL 746C
Printed-Wiring Boards, Electrical — UL 796
Switches, Clock-Operated — UL 917
Switches, General-Use Snap — UL 20
Switches, Special-Use — UL 1054
Temperature-Indicating and -Regulating Equipment — UL 873
Terminal Blocks, Electrical — UL 1059
Terminals, Quick-Connect — UL 310
Thermal Protectors for Motors — UL 547
Transformers, Specialty — UL 506
Valves, Electrically Operated — UL 429
Wire Connectors and Soldering Lugs for Use With Copper Conductors — UL 486A
Wires and Cables, Rubber-Insulated — UL 44
Wires and Cables, Thermoplastic-Insulated — UL 83